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July 16, 1948

Science

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(See page 52)

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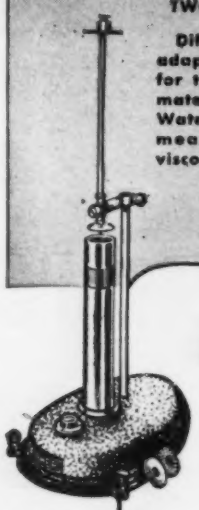

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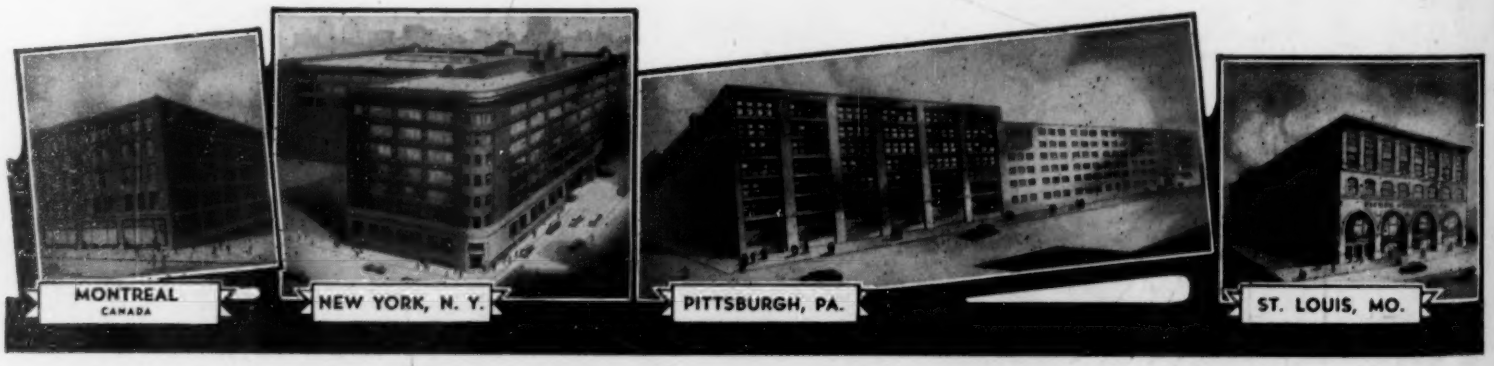

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Scientist and Politician as Partners:

The British Parliamentary and Scientific Committee

Hugh Linstead

Secretary, Pharmaceutical Society of Great Britain,
and *Member of Parliament for Putney*

SCIENTISTS DO NOT MAKE THE BEST politicians, nor do politicians make the best scientists. Yet science and politics interact one on the other, and there is real need for a common meeting place. In Great Britain, the Parliamentary and Scientific Committee is the means we have found for bringing the two groups together so that the scientist can influence the development of political questions, the politician can advise the scientist on the practical aspects of some of his problems, and the two together, politician and scientist can join in representations to the Government.

The Committee is a nonparty body formed with the object of providing a permanent liaison between scientific bodies and Parliament and serving generally as a center for the consideration and discussion of scientific information bearing on current business in Parliament. Its parliamentary membership is made up of Members of both Houses, Lords and Commons, while its scientific membership consists of representatives of bodies "of a scientific or technical character" who satisfy the Committee that they are "a National Institution or Association of qualified scientists or technologists or a Research Organisation or a body the special position of which in the scientific life of the country makes its membership, in the opinion of the General Committee, desirable in order to advance the agreed objects of the Committee." There are some 200 peers and M.P.s who are members and about 80 scientific bodies. An idea of the range of the latter can be gathered from a representative selection—the British Association for the Advancement of Science, the British Cast Iron Research Association, the Chemical Society, the Pharmaceutical Society of Great Britain, the Institution of Structural Engineers, the Gas Research Board, the Royal Institute of British Architects.

The chairman is a member of the House of Commons belonging to the party in power, and the deputy chairman, a member from the ranks of the Opposition. The full Committee, which meets monthly in a committee room of the House of Commons, has a Parliamentary Action Subcommittee of the Members of the two Houses to handle the exclusively parliamentary aspects of its problems and a Steering Subcommittee, comprising the parliamentary members together with selected nonparliamentary members, "to plan in advance the activities of the General Committee."

The aims and objects of the Committee have been more precisely defined in the following terms:

It is felt that substantial benefits should result if the numerous Societies concerned with scientific activities combine their influence with the object of ensuring that Parliament shall have proper regard for the importance of scientific methods in relation to public affairs.

Steps will be taken by the Committee to enlist the interest and support of as many Scientific Societies as possible so that the influence of Science can be made as effective as possible in the councils of the State.

The Committee will also endeavour amongst other things:

(1) To provide Members of Parliament with authoritative scientific information from time to time in connection with debates.

(2) To bring to the notice of Members of Parliament and Government Departments the results of scientific research and technical development which bear upon questions of current public interest.

(3) To arrange for suitable action through Parliamentary channels whenever necessary to ensure that proper regard is had for the scientific point of view.

(4) To examine all legislation likely to affect the above and take such action as may be suitable.

(5) To watch the financing of Scientific Research.

(6) To provide its members and other approved Subscribers with a regular summary of scientific matters dealt with in Parliament.

A review of some of the "operations" planned and carried through by the Committee will give the best indication of the scope of its work and of the methods it employs.

In the early months of 1945 the Committee prepared a memorandum upon Salaries in the Government Scientific Service. It pointed out that the main requirements were: "(i) improved salaries for the higher directing posts so as to ensure at the head of the Civil Service Scientific Departments no less able men than in similar posts outside the Civil Service; (ii) better pay and prospects for the Civil Service

This article was prepared by Mr. Linstead in response to a request made by the staff of the Chief Scientific Officer, American Embassy, London.

scientific staff as a whole so as to bring these more into line with those of the Civil Service Administrative Staff; (iii) simplification of the whole system and elimination as far as possible of the present 'dead-end' posts and pockets."

It was further suggested that salaries in the Government Scientific Service should range from £3,250 a year for a Chief Scientific Adviser to a scale of £1,150–£1,500 for Senior Principal Scientific Officers, while the basic grades should range from £850 to £1,050 for Principal Scientific Officers down to £275–£347 for Junior Scientific Officers.

This memorandum was sent to the Government, which in September 1946 published its own proposals for the reorganization and recruitment of the Scientific Civil Service. These fell short of the goal which the Committee had indicated as desirable, appearing merely to provide for parity of pay between the best scientist and the average administrator. The Committee accordingly sent a deputation to the Financial Secretary to the Treasury—the Minister second-in-command to the Chancellor of the Exchequer—and put its case to him in more detail. This produced a letter from the Government to record that "so far from accepting the view that the scientist is inferior to the Administrative Officer, its aim is to ensure that scientific workers will, man for man and job for job, be in as good position as other staff." The Government also stated that "provision is being made for a 'pool' of senior posts to which individuals may be appointed on their own merits as scientists, and independently of the number of such posts required for the normal work of the Department." The Government has not so far amended the salary scales, and the Committee must continue to press upon it the necessity, first, of paying such salaries to scientific officers as will attract the best men and, second, of enabling those men to reach the highest administrative posts in the Civil Service.

The Committee has studied the extent to which relief from taxation can be used to encourage research in industry. Its recommendations were taken into account by the Government when in 1946 changes in tax law came into effect, allowing exemption from taxation not only for expenditure incurred by a firm on research in its own laboratories, but when such expediture took the shape of grants for research to external agencies, as, for example, universities.

As far back as October 1943 the Committee, looking forward to Britain's postwar problems, issued a report on "Scientific Research and the Universities in Postwar Britain." It recommended an all-around expansion of facilities for scientific education in the universities and colleges of technology with the particular object of increasing the supply of first-class scientific personnel. It urged that a capital sum of at least £10,000,000 should be assigned for buildings and equipment during the first 5 postwar years and that the annual grant to the universities from the Treasury should be trebled. Shortages of men and materials have since prevented the realization of these proposals in full, but at that time the response of the Government to the Committee's report was generous and encouraging. The Chancellor of the Exchequer in February 1945 recorded the recognition by the Government of the needs of the universities for capital development as about £18,750,000 and of the medical schools as an additional £10,000,000.

In 1944 the Committee studied the organization of industrial research and development in British industry and recommended the setting up of a Government inquiry "to consider the lines along which immediate, vigorous and large-scale application of scientific knowledge would be likely to produce the most fruitful results." The first date arranged for a discussion of these proposals with the Government was the day of the death of President Roosevelt, and the conference was postponed. Discussions took place, however, shortly before the General Election of 1945, and the new Government acted upon the advice of the Committee and appointed a commission of leading scientists and others "to consider the policies which should govern the use and development of our scientific manpower and resources in the next ten years."

As an example of another type of investigation by the Committee, reference may be made to the reports of the Subcommittee on Coal Utilization, issued in 1947. The members responsible for it were scientists connected with the coal industry, together with Members of Parliament and Peers, including an ex-Minister of Fuel, having special knowledge of the coal industry. The first report dealt with the urgent problems of coal utilization which had been revealed when fuel shortage stopped factories during the winter of 1947. The Committee urged on the Minister two principles: (1) that each industry should receive an allocation of coal in accordance with a system of priorities worked out in the national interest; and (2) that fuel efficiency should be encouraged and that some reward should be obtained by those firms which utilize their fuel more efficiently than others. The report then surveyed methods of spreading the electricity peak load, the weight of which at that time was causing power cuts and interruption of production. It also examined the possibility of limiting the conversion of coal-burning to oil-burning plant to only those schemes where an advantage could be secured on a long-term program. It had, too, some advice to give on the screening and washing of coal at the pithead. The Minister of Fuel and Power did more than give the

report a courteous acceptance; he put a number of its recommendations into effect that same winter.

Steel shortages were examined by the Committee in the same year. Members of the Committee were anxious that, in the competition for steel, the claims of steel for new machines and other devices that would secure economy should not be overlooked. They urged in a report to the Minister of Supply that "Prime Minister's List" priority, *i.e.* top priority, should be given to steel for plant to secure more efficient utilization of fuel. The steel and fuel industries advised the Committee, and the Committee examined and accepted their advice, that an annual saving of 18,000,000 tons of coal was possible if the steel needed for re-equipping combustion plants could be released. It was estimated that not more than 5 years would suffice to achieve this and that 1 ton of steel could secure a saving of 40 tons of coal annually.

One of the largest pieces of work undertaken recently by the Committee has been a report on the manner in which colleges of technology can assist in increasing the scientific manpower of Great Britain. After a long enquiry and after hearing evidence which included the views of an American educationist, the Committee produced a series of recommendations which have been sent to the Minister of Education, who has met representatives of the Committee to discuss them. Finding that scientific and technical research widely carried out and promptly applied to production is essential to restoring and enhancing the industrial position of the country, the Committee assigned to the major colleges of technology the production of 5,000–7,000 qualified technologists and scientists annually by means of courses in technology of a standard equivalent to that of university courses. It proposed ways and means whereby this might be achieved and the progress of technological education developed. A very short while after the publication of its findings, the Committee was assured by the Minister that development within his Department would be substantially along the lines mapped out by the membership.

The Committee has made it its special business to follow closely the progress of the research program in the Government's own laboratories, especially work on atomic fission. It advised the Government on the organization of national research, and it was in response to a question asked in the House by the Committee's vice-chairman that the Government announced that, in addition to the Defense Research Policy Committee, there was to be set up on the civil side an Advisory Council on Scientific Policy to advise the Government upon the formulation and execution of government scientific policy generally.

Individual Members of Parliament on behalf of the Committee raise innumerable matters at question time in the House, and groups of Members lobby Ministers on subjects of greater importance. The importation of scientific books into Great Britain during the dollar shortage was one of these. On this question a debate was arranged by members of the Committee, and the Parliamentary Secretary to the Board of Trade was compelled to admit, although with ministerial caution, that "there is a case for some slight weighting of the scales on the side of technical works." The Committee then set on foot an enquiry from all scientific bodies affiliated with it to find out how the import restrictions are affecting their members, in order to get a full picture of the handicaps under which British scientists may be suffering. It was also as the result of representations from members of the Committee that the President of the Board of Trade undertook to ensure to journals devoted primarily to original research their full requirements of paper and said that he at least hoped to exempt technical periodicals from the reductions on paper he was imposing on publishers generally.

The British Parliament has been traditionally a place where grievances can be ventilated. The Parliamentary and Scientific Committee has proved to be an admirable forum for this purpose where the "grievance" has a scientific or technological basis. For example, representatives of two great industries—the scientific instrument industry and the fine chemical industry—came to the Committee to express the alarm of those industries at the rehabilitation of the corresponding industries in Germany with apparently little regard on the part of the Government to the effect on British firms. The Committee has shown, too, that it can be a valuable forum for the discussion of major development projects that are still in embryo and need publicizing. The Channel Tunnel between England and France is one of these. Another is the Thames Barrage, to be built in order to hold up the in-sweep of the tide below London and thus keep the river through most of London fresh and unpolluted.

Ministers and others attend and address the Committee and senior civil servants obtain special permision to discuss the work of their departments with it—a concession not readily granted by any Government which in the nature of things feels itself on the defensive in its dealings with Parliament.

A word about the Committee's attitude toward lobbying by industrial or scientific interests will not be out of place. Members of Parliament and Ministers of the Crown are, of course, subjected regularly to the pressure of interested bodies over the whole range of governmental activity. Because of the special authority which the Parliamentary and Scientific Committee has established for itself, it would be a most effective machine for this purpose, and from time to

time it has proved itself to be so. But the price of its authority is the rigorous standards it has set for itself. No industry or group of professional men which may, through one body or another, chance to be represented on the Committee acquires thereby any right to call upon the Committee to sponsor any demands it may have to make upon the Government. It may put its case to the Committee, but that case will be most acutely examined, and it will be only where considerations of scientific or national importance are clearly shown to be involved that the weight of the Committee's support will be given. It is by such selective advocacy that the Committee has developed its authority in the eyes of the Government and its true value to those who support it.

The foregoing account of some of the work of the Committee up to the present time will indicate the lines along which it pursues its aims. It has been greatly encouraged by the creation in Canada of a corresponding body, the Canadian Parliamentary and Scientific Committee, formed at Ottawa on April 25, 1947. That organization is in course of development through an Interim Committee consisting of representatives of the Professional Institute of the Civil Service of Canada, the Engineering Institute of Canada, the Canadian Council of Professional Engineers and Scientists, the Canadian Mathematical Congress, and the Canadian Association of Scientific Workers, together with Members of Parliament representing the four different parties in the Canadian Parliament.

No account of the British Committee would be complete without a reference to its secretarial arrangements. Such a committee cannot flourish, nor can the interest of a couple of hundred busy men be retained, without central organization and direction of high quality. The drafting of reports, the documentation connected with meetings, and the briefing of the parliamentary Members would seem to require an elaborate secretariat. In fact, the Committee has been able to deal successfully with a wide range of problems with the minimum of organization, largely through the energy and ability of its secretary, Cdr. C. Powell, R.N. (ret.), whose office is at 6 Queen Anne's Gate, London, S.W.1.

Great Britain's future is dependent upon the extent to which she can retain and develop her capacity for industrial production and upon her power to foster and exploit scientific research. In these vital fields there is a clear interlocking of science and politics. The task of the Parliamentary and Scientific Committee over the next few years is therefore clear. It is to unite the forces of politics and of science to ensure that government policy is shaped and carried through with these vital objectives constantly in view.

Obituary

Rollin Thomas Chamberlin

1881–1948

Rollin T. Chamberlin, professor emeritus of geology at the University of Chicago, died March 6, 1948, following his third coronary thrombosis within four years. His age was 66. The son of a great geologist, he was great in his own right in the field of earth science. He was internationally known from his writings, and he had acquaintances and friends throughout the world, for he had traveled extensively on all the inhabited continents.

He was born in Beloit, Wisconsin, where his father was professor in Beloit College. As his given names indicate, the long-time association of Thomas C. Chamberlain and Rollin D. Salisbury had already begun. Before his college years arrived, the University of Chicago opened, with his father and Salisbury on the newly recruited staff. Rollin Chamberlin's B.S. and Ph.D., therefore, were from Chicago, although he did some work in the Universities of Zurich and Geneva. His early interests were geochemical, his doctor's thesis being on "The Gases in Rocks."

Later, his chief interest swung to structural and dynamic geology, in which he became an outstanding and widely quoted authority in both laboratory experimentation and broad field investigation. His bibliography shows, however, an exceptionally wide range of investigations and critical studies. He is known among glacialists for his studies of glacial erosion and his field demonstration of the actuality of glacial shearing. From such, in part, flowed his study of glacial ice as a dynamically metamorphosed rock. He was one of the field investigators of the once widely heralded Pleistocene Man of Vero, Florida, and he contributed to the elucidation of the Pleistocene stratigraphy of the north central United States. He also wrote an authoritative paper on the origin of the coral reefs of the South Pacific. His work on gases in coal resulted in the present generally used roek-dust treatment of the entries to reduce the inflammability of

the unavoidable coal dust. In the field of physiography he wrote a significant paper on an overlooked but fundamental item in the concept of base-level. His knowledge of recurrent orogenies in earth history made papers on geologic classifications and correlations inevitable. An Alpine enthusiast, he is in the mountaineer's bibliography.

Chamberlin's most important field of geologic contribution was diastrophism. In orogeny, he wrote on the structure of various mountain ranges, on the mechanics of various kinds of faults, on the depth of folding, and on mountain ranges as deep wedges in the "crust." Volcanism, closely associated with orogenesis, had his attention; "Whittling Down the Batholiths" was one particularly catchy title. The close relationship of epeirogenic diastrophism with orogenesis was another theme. He had little toleration for the theory of continental drift, believing in deeply rooted continental and oceanic units through geologic time. With a share in field measurements as a part of his background, he somewhat sharply criticized the more enthusiastic applications of the theory of isostasy. Diastrophism and volcanism in making the moon's topography is the subject of his most recently published paper.

Chamberlin wrote less for students than for researchers, but, with Paul MacClintock, he twice revised the college text of T. C. Chamberlin and R. D. Salisbury. He also wrote a chapter in *The nature of the world and of man* (there were 16 authors) and its later revision under the title *The world and man, as science sees them.*

Among scientific organizations Chamberlin worked in close association with, or under the direction of, the Carnegie Institution of Washington, the U. S. Geological Survey, and the National Research Council and held official positions in Sigma Xi, the American Association for the Advancement of Science, and the Geological Society of America. In addition, he was a member of a number of other scientific organizations, including the National Academy of Sciences and the American Philosophical Society.

Chamberlin taught in the Department of Geology of the University of Chicago from 1912 until 1947 and was editor of the *Journal of Geology* from 1922 until his retirement from the faculty in 1947. His career was a normally long, very busy, and unusually fruitful one. His was the happy blending of the teacher and researcher, with that otherwise unattainable result: his students were fired by his own enthusiasms for pushing back the darkness bordering the periphery of his problems. He sired more doctors' theses in his department than has any other staff member during its existence. His was a certain boyishness that delighted in fun with his students. His was the gift of friendliness. Few members of the University of Chicago faculty knew so many others so well.

Chamberlin, after his first and second heart attacks, refused to surrender and retire before the obligatory age of 65. He finished successfully and had a few months more, although much writing he planned after laying down the teaching and editorial duties now never will be done. Geology has lost an outstanding figure and his colleagues an irreplaceable comrade.

J HARLEN BRETZ

The University of Chicago

The U. S. Naval Observatory

The U. S. Naval Observatory, founded in 1842, sets the Nation's clocks and derives and publishes astronomical information in the public interest. Continual observations of the positions and motions of the sun, moon, planets, principal stars, and other objects are maintained, making possible the advance predictions published annually in the American Ephemeris and the Nautical and Air Almanacs. These volumes are used by all marine and air navigators and by surveyors, astronomers, and other scientists.

The Observatory pioneered in the development of the photographic zenith tube for accurate time determination. This instrument, now being adopted by other principal nations, contributes to the present high accuracy of frequency standards used in radio communication and other applications of electronic techniques. Here, also, the transit circle and its auxiliary apparatus, used for fundamental determinations of celestial positions, have been developed to their present degree of accuracy and efficiency.

By international agreement the tables derived at the Observatory for calculating the positions of the sun and planets have been adopted for official use all over the world, as have also certain star catalogues and fundamental constants of astronomy. The Observatory has, in addition, made notable contributions to celestial mechanics and mathematical astronomy.

Now under way is a large-scale investigation in cooperation with the Yale University Observatory and the Watson Scientific Computing Laboratory, sponsored by the Office of Naval Research, and intended to place on a firmer mathematical and observational basis the theories of motions in the solar system. Also in progress is a topographical survey of the moon's marginal zone, which will greatly increase the usefulness of this body for long-distance triangulation on the earth, for determining the variability in the earth's rate of rotation, and for several astronomical purposes.

The Observatory is organized in 5 astronomical divisions, each under the supervision of an astronomer, administered by the Department of the Navy through the superintendent, Capt. Guy W. Clark, USN. The two Divisions of Meridian Astronomy, under C. B. Watts and F. P. Scott, determine fundamental positions of the sun, moon, planets, and stars. The Time Service, under Paul Sollenberger, determines accurate time and, with the same instrument, the variation of latitude. The Division of Equatorial Instruments, in charge of H. E. Burton, observes satellites, minor planets, and other objects too faint or otherwise unsuitable for the meridian instruments. The satellites of Mars were discovered in 1877 with the 26″ telescope. The Nautical Almanac Office under G. M. Clemence, utilizes the results of the observations and calculates and publishes the three annual publications of the Observatory; the assistant director is E. W. Woolard.

For the second time in its history the Observatory is preparing to move to a location more suitable for astronomical work. The original site, north of the Lincoln Memorial, was vacated in 1893. The present location, at Massachusetts Avenue and 34th Street, N.W., was then satisfactory but has since deteriorated astronomically due to the growth of the city.

Symposium on Genes and Cytoplasm

One of the symposia planned for the Centennial Celebration is to deal with Genes and Cytoplasm. The fundamental importance of the gene in all kinds of creatures from microorganisms to man is widely recognized, but *how* genes accomplish their great effects, control of the biochemical, physiological, structural and behavioral properties of the organism, has only within the last decade been subjected to concentrated exploration on a scale and in a manner that may lead to a general solution. This broad question involves two distinct problems that have been attacked by different experimental methods. On the one hand is the problem of the nature of the primary activity of genes, their first and possibly their only direct activity. On the other hand is the problem of how these basic gene activities can result in the development of an organism with its cells and tissues alike in genes but different in hormone and enzyme production, in structure, and

in behavior. The problem of abnormalities in development, such as cancer, is, at least in part, a special case of the more general problem of developmental differentiation. Not only are the diversities among cells of one body cytoplasmic, but the products of gene activity operate *in* the cytoplasm, and there appear to be, moreover, cytoplasmic materials (plasmagenes) comparable to nuclear genes. The cytoplasm must therefore be investigated along with the genes in attempts to discover what genes do and how cells with the same genes become diverse. These two major problems are dealt with from biochemical, genetic, and embryological points of view by the three papers to be presented in this Symposium.

One of the most fruitful trends in modern work has been the shift of attention from morphological traits, which are remote from the primary action of genes, to biochemical properties of the organism, which must underlie the morphological traits and be more directly related to primary gene activity. Among biochemical traits, two classes have held out the greatest promise of being close to primary gene activity: enzymes and antigens. Indeed, it has even been suggested that the primary products of gene activity may be enzymes, antigens, or their specific reactive molecular groupings. In this field, no modern investigation has been more successful or attracted more attention than the biochemical genetics of the bread mold, *Neurospora,* a program initiated by the geneticist Beadle in collaboration with a group of biochemists led by Tatum. One of the initial members of this group, the biochemist, David Bonner, of Yale University, will present a paper on the status of genic control of biochemical reactions and the possibility of arriving, by such studies, at a knowledge of the gene and its primary activity.

Whatever conclusions are reached as to the primary action of a gene, they will have to be reconciled with many facts discovered by the methods of genetics. Among these are the facts on which are based the concepts of position effect, interaction of alleles, and genic balance. The activity of a gene may be modified either in dependence upon its position in the chromosome, or by the kind of allele present in the same nucleus, or by the ratio between the number of genes of one kind and the number of genes of other kinds present in the nucleus. These phenomena, puzzling in themselves quite aside from the difficulty of reconciling them with the rapidly growing knowledge of biochemical genetics, form the subject of a paper to be presented by Curt Stern of the University of California, Berkeley. Prof. Stern, who is a member of the National Academy of Sciences and has had a distinguished career as a geneticist since obtaining his doctorate at Berlin in 1923, has discovered new facts in these fields and interpreted them by theoretical concepts to account for these difficult matters. These concepts, moreover, lend themselves readily to a reconciliation between them and the new biochemical genetics.

The biochemical approach represented by Bonner and the genetic approach of Stern go far towards providing us with insight into the primary activity of genes. There remains, however, the essentially embryological problem of accounting for the origin of differences among cells with the same genes. Here a decisive role of cytoplasmic factors has long been suspected. In agreement with this, German plant geneticists have for over 20 years been accumulating evidence for the existence in the cytoplasm of gene-like determiners. Similar agents have more recently been discovered in a few animals by French, American, and English workers. Curiously enough, though the problem is essentially an embryological one, the main clues to its solution have come from studies on unicellular organisms, in which all the cells produced by one ancestor are usually alike in traits as well as in genes (yeast, bacteria and the protozoan *Paramecium*). It is no accident that the traits investigated in these organisms are mainly enzymes and antigens, the two classes of substances held to be most closely related to gene activity. An account of this work will be presented by T. M. Sonneborn, of Indiana University, also a member of the National Academy of Sciences and the leader of a group that shared the 1946 prize of the American Association for the Advancement of Science for their studies on *Paramecium.* The work to be reviewed by Prof. Sonneborn leads to the view that the products of gene activity, such as antigens, are themselves endowed with the genic property of self-duplication and that competition among these plasmagenes gives rise to persistently diverse cell types.

With this full turn of the wheel, there emerges the beginning of a synthesis. Each gené performs a definite biochemical activity, probably conferring specificity upon the more complex materials of the cell, such as enzymes (Bonner); in this activity, the genes vary in their affinity for the substrates on which they operate, and they vary in their efficiency in operating upon them (Stern); the enzymes and antigens specified by gene activity may themselves be gene-like (plasmagenes), and the diversities arising among cells with the same genes may be due to the different results of competition among them under different conditions (Sonneborn). This symposium attests to the attainment, by biochemistry, genetics and embryology, of common ground from which springs a tentative general view of the nature of gene action in heredity and development.

NEWS and Notes

N. A. Whiffen, senior scientific liaison officer of the Australian Embassy for the past 5 years and officer-in-charge since 1945, has been appointed principal research officer of the Australian Council of Scientific and Industrial Research. In his new post, which will be located in Geelong, Australia, Mr. Whiffen will be principally concerned with assisting the Council in the management of its wool research program.

J. Calvin Potts, formerly of the California Research Corporation, Richmond, recently joined the staff of the Chemistry and Metallurgy Division of the University of California's Los Alamos Scientific Laboratory.

John Gregory, of the University of Cincinnati, has been appointed head of the Department of Pathology, Hahnemann Medical College.

Gennady M. Kosolapoff will become an associate professor of chemistry, Alabama Polytechnic Institute, in September. For the past 10 years, Dr. Kosolapoff has been engaged in research in the field of phosphorus chemistry at the Monsanto Chemical Company.

Donald P. Cottrell, dean of Ohio State University's College of Education, will head a commission making an educational survey in the Philippine Islands this summer. The survey, under auspices of the Foreign Missions Conference of North America, will explore methods for improving some 50 educational institutions destroyed or damaged during the war. In relation to this study Dean Cottrell will also visit Chinese and Japanese schools.

Robert F. Nystrom, research chemist of the Clinton Laboratories, has been appointed assistant professor of animal science and chemistry at the University of Illinois. In his new position, Prof. Nystrom will also have charge of the University's new Radiocarbon Laboratory, which will be a service department for various groups interested in using radioactive isotopes of carbon as well as a laboratory for developing methods of study with this material.

Philip S. Baker, of the Department of Chemistry, University of Vermont, has been named associate professor in charge of analytical chemistry at Bradley University, Peoria, Illinois.

John R. Laughnan, of Princeton University, was recently appointed an assistant professor of botany at the University of Illinois.

Charles E. Van Hagan, formerly of the U. S. Forest Products Laboratory, has been named the new secretary-treasurer of the Forest Products Research Society, to succeed **Thomas R. C. Wilson** who, on completing his work with the Society in August, will resume his practice as a consulting timber engineer.

Rafael Rodriguez-Molina, chief of Medical Service, VA San Patricio Hospital, San Juan, Puerto Rico, has been appointed governor for Puerto Rico of the American College of Physicians.

Leland I. Cothern, head of the Department of Mining Engineering, Virginia Polytechnic Institute, will join the faculty of Ohio State University on October 1.

Grants and Awards

The Geological Society of America has announced the project grants recently made from the Penrose Fund. The receipients and their respective studies follow: Charles L. Camp and Samuel P. Welles, University of California, Berkeley, bibliography of fossil vertebrates, $6,000; George P. Woolard, Princeton, New Jersey, gravitational and magnetic strip survey along the Canadian border, $7,570; Franco Rasetti, Johns Hopkins University, revision of some Cambrian sections in the Canadian Rockies, $1,025; Arthur N. Strahler, Columbia University, investigation of general principles of slope and drainage development, $1,330; Bronson Stringham, University of Utah, alteration studies of copper ore body at Bingham, Utah, $3,088; John B. Lyons, Dartmouth University, geology of the Hanover Quadrangle (New Hampshire-Vermont), $350; Anna Hietanen-Makela, Stanford University, petrology and petrofabrics in the Feather River Canyon, Sierra Nevada, California, $700; John T. Stark, W. E. Powers, A. L. Howland, Northwestern University, and C. H. Behre, Columbia University, geology of South Park, Colorado, $350; Margaret Jean Hough, Washington, D. C., studies in the evolution of the Carnivora, $3,500; John T. Sanford, Wayne University, Siberian Silurian fossils, $750; Albert E. Wood, Amherst College, comparative genetic studies of fossil and living mice by means of tooth variation, $5,600; Chester R. Longwell, Yale University, study and mapping of the area in Arizona and Nevada to be flooded on completion of the Davis Dam on the Colorado River, $1,650; Thomas P. Bates, Pennsylvania State College, electron microscope study of the mineralogy and petrology of the clay minerals, $2,000; and H. A. Einstein, J. W. Johnson, University of California, Berkeley, and P. D. Trask, U. S. Geological Survey, dynamics of sedimentation in the Salinas River, California, $2,000.

The American Foundation for High Blood Pressure recently announced that applications for grants for research in hypertension and arteriosclerosis may be made to the chairman of its Allocations Committee, Harry Goldblatt, Cedars of Lebanon Hospital, Los Angeles, California.

Hunter Rouse, professor of fluid mechanics at the State University of Iowa and director of the Iowa Institute of Hydraulic Research, recently received the $1,000 George Westinghouse Award of the American Society for Engineering Education. The award, made annually for distinguished contributions to the teaching of engineering students, was presented to Dr. Rouse at the annual meeting of the Society held in Austin, Texas.

Kasimir Fajans, professor of physical chemistry at the University of Michigan, has been awarded the Medaille de l'Universite de Liége. Dr. Fajans has been spending a portion of his sabbatical leave in Europe visiting and lecturing at the Univer-

sities of Oxford, Cambridge, Brussels, Liége, Leiden, and Amsterdam.

Frederick C. Blanck, administrative fellow of the H. J. Heinz Company fellowships at the Mellon Institute, has been awarded the first Stephen M. Babcock Award of the Institute of Food Technologists. The award, made in recognition of Dr. Blanck's contributions to the field of food technology, together with the $1,000 accompanying prize, will be presented at the annual meeting of the Institute of Food Technologists in Philadelphia.

Colleges and Universities

The Yale Institute of Alcohol Studies in the Southwest was inaugurated recently at Fort Worth, Texas, as a cooperative project of Yale and Texas Christian Universities to provide a long-range research and clinical center. As now planned, the Institute will comprise a research unit in the social sciences at Texas Christian, a clinic for the rehabilitation of alcoholics at Dallas, a Summer School of Alcohol Studies at Trinity University, San Antonio, and informal educational activities at all levels throughout Texas.

Administration of the Institute will be centered at the Yale Laboratory of Applied Physiology under its director, Howard W. Haggard. Elvin M. Jellinek, director of the Section of Studies on Alcohol at Yale, is now in Fort Worth to organize the Institute, and will later conduct the Summer School at San Antonio.

A Training Conference on Industrial Experimentation will be offered September 14–18 by the Engineering School of Columbia University. The course is intended to provide both formal and practical insight into fundamentally effective techniques for those having a background of experience and at least one course in statistics, quality control, or the equivalent. Topics to be considered are: the nature of problems in industrial experimentation, role of control charts, correlation, analysis of variance and their interrelation in the design of experiment, assumptions underlying analysis of variance, one-way and two-way classifications, Latin squares, factorial designs, and sequential methods, together with a special session on computing machines.

S. B. Littauer and R. E. Bechhofer, of the Department of Industrial Engineering, and J. Wolfowitz, Department of Mathematical Statistics, all of Columbia, will serve as full-time Conference instructors. Industry specialists who will participate in the afternoon clinic sessions include: Beverly Clarke, of Merck and Company, E. V. Lewis, of Du Pont, Harry Romig, of Bell Telephone Laboratories, Col. Leslie E. Simon, Aberdeen Proving Ground, and Ralph E. Wareham, National Photocolor Corporation.

Requests for brochures, applications, and information about fees and accommodations should be addressed to S. B. Littauer, Department of Industrial Engineering, Columbia University, New York 27, New York.

The Metallurgy Building of the newly named Ames Laboratory of the U. S. Atomic Energy Commission at Iowa State College was dedicated in a cornerstone laying ceremony held during the school's "Veishea" ceremony in May. In view of the importance of the work done in the Institute for Atomic Research in the College and that done earlier at Ames by the Manhattan District, the Commission has designated the project one of its permanent laboratories. The AEC authorized the Metallurgy Building, to be constructed at a cost of about $1,000,000, to house the latest equipment of a specialized nature for the use of metallurgists, chemists, physicists, and engineers. In connection with this project, the College is erecting an Administration Building for the Institute and plans to start construction on the Synchroton Building this summer.

Industrial Laboratories

The first of a projected series of motion picture films on endocrinology, "The Physiology of Normal Menstruation," has been released by the Schering Corporation. The script of the film was written by Somers Sturgis, of the Massachusetts General Hospital and the Vincent Memorial Hospital Laboratory, and John Rock, of the Harvard Medical School and the Endocrine and Rhythm Clinics of the Free Hospital for Women, Brookline, Massachusetts. Previews have been presented at meetings of the Endocrine Society of Philadelphia and the American Medical Association. The film was produced by the Schering Corporation for the use of medical schools and medical societies and may be obtained free of charge for showing before interested groups by writing to the Medical Service Department, Schering Corporation, Bloomfield, New Jersey.

Bio-Science Laboratories, Inc., a new biological and biochemical research laboratory, has been formed by Sam Berkman, Orville J. Golub, Richard J. Henry, and Milton Segalove. The members of the new organization, which is located at 10717 Venice Boulevard, Los Angeles 34, California, were formerly at Camp Detrick, Frederick, Maryland. The firm will specialize in research and control work for the food, drug, and allied industries.

Meetings and Elections

A Human Genetics Society of America has been organized the past few months. Its purpose is to bring into closer contact the many investigators in the various fields of inquiry who are interested in human genetics problems, to encourage and integrate research in human genetics, and to deal with other problems related to human genetics. Its membership totals at present about 200 drawn from the fields of anthropology, child development, genetics, immunology, medicine, pathology, population problems, public health, psychology, psychiatry, serology, sociology, statistics and others. Its elected officers for 1948–49 are: H. J. Muller, president; L. H. Snyder, vice-president; and H. H. Strandskov, secretary-treasurer. The society will hold its first meeting at Washington, D. C., September 11–13, just prior to the AAAS Centennial Celebration. Full details regarding the meeting will be sent to members. Information relative to membership in the Society may be obtained from the secretary, Herluf H. Strandskov, Department of Zoology, University of Chicago, Chicago 37, Illinois.

The American Physiological Society has announced the election of the following officers for 1948: Maurice B. Visscher, president; Carl J. Wiggers, president-elect; and D. Bruce Dill, councilor and secretary-treasurer of the council. Milton O. Lee has been appointed executive secretary of the Society, and William T. Porter elected to honorary membership.

The fall meeting of the Society will be held September 15–18 in Minneapolis with headquarters at the University of Minnesota. Special features will include laboratory demonstrations, organized symposia, and a conducted tour of the Mayo Foundation. Each member will be entitled to present one paper and one demonstration. Titles of submitted papers, and reservations for housing, demonstration space, and the Rochester trip should be sent to Ancel Keys, Stadium Laboratory, University of Minnesota, Minneapolis 14, Minnesota, by August 7.

The South Dakota Academy of Science at its 33rd annual meeting held at Huron this spring elected the following officers: Victor S. Webster, of South Dakota State College, president; Emerson G. Cobb, of Dakota Wesleyan University, first vice-president; John A. Froemke, of Augustana College, second vice-president; and A. L. Haines, of the University of South Dakota, secretary-treasurer. The two-day session was addressed by H. Vernon Price, of the State University of Iowa, and a large group of papers was presented by participating members.

Deaths

James L. Campbell, 77, professor emeritus of clinical surgery at Emory University, died June 11 in Atlanta, Georgia, following a heart attack.

Hans O. Haterius, 46, head of the Department of Physiology, Boston University School of Medicine, died June 28 in Boston following surgery. He had done extensive research in the field of endocrinology.

Frank Rieber, 57, geophysicist, died June 30 in New York City. He had most recently been engaged in developing a new system for seismic exploration and the mapping of complex geological conditions.

Thomas M. Woodward, Jr., 43, associate professor of biology at Vanderbilt University, died suddenly of a heart attack on July 3 in Nashville.

Eli F. Burton, 69, head of the Department of Physics at the University of Toronto, died July 6 in Toronto. Dr. Burton was best known for his development of the electron microscope and his successful treatment of cancer with colloidal arsenic.

The King Gustaf V Research Institute, for the combating of invalidizing diseases, was recently inaugurated in Stockholm by the King. Built from funds collected on the occasion of King Gustaf's 80th birthday, the Institute will be devoted primarily to research on rheumatic diseases. Among the equipment ready for installation is an electron microscope, built in Sweden by Manne Siegbahn, nuclear physicist and Nobel Prize winner. There will also be available for investigations at the Institute two special laboratories, the refrigeration laboratory permitting studies to be made at temperatures down to −40° C, and one for electrophoretic blood research.

Three new departments in the Nobel Institute for Medical Research had been inaugurated only a few days earlier. These will be devoted to biochemistry, under Hugo Theorell, to cell research, under Torbjörn Caspersson, and to neurophysiology, under Ragnar Granit.

The American Phytopathological Society recently published Phytopathological Classic No. 8 in the series of translations and reprints of early papers in the field of plant pathology. This volume, *Observations, botanical and physiological on the potato murrain,* by the English plant scientist, Miles Joseph Berkeley, also contains selections from the author's *Vegetable pathology,* made by the Plant Pathology Committee of the British Mycological Society. Orders for the volume, which is priced at $1.50, should be made payable to Phytopathological Classics and addressed to L. J. Tyler, Department of Plant Pathology, Cornell University, Ithaca, New York.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, has listed the following wanted chemicals: hydnocarpic acid, kellin, fructose-6-phosphate, germanochloroform, tantalum boride, boron sulfide, rubrophen, hypoxanthine desoxyribose phosphoric acid, potassium chromium thiocyanate, indigo red, myristicin, 1,16-hexadecane dicarboxylic acid, zirconium boride, thorium boride, thymine desoxyribose phosphoric acid, 1,4-diaminonaphthalene, trichloroacetyl chloroethylamide, 2-mercapto-1,3-propanediol, and 1,3-nonadiene.

The Hayden Planetarium in New York City is now offering a summer series of ten informal, popular lectures in meteorology and weather forecasting. The sessions opened on July 8 and will be presented each Thursday night at 7:30 P.M. through September 16. The next lectures in the course will be: "We Walk on the Bottom of an Air Ocean" (July 22); "The Great Generator Sun, and Primary Circulations" (July 29); and "The Air Mass Histories" (August 5). Frank H. Schleifer, Marine Corps meteorologist, will direct the program. Individual lectures may be attended at $1.50 per lecture.

Making Plans for—

General Assembly and International Congress of the International Union of Crystallography, July 28–August 3, Harvard University, Cambridge, Massachusetts.

Applied Mathematics Symposium of American Mathematical Society, July 29–31, Massachusetts Institute of Technology, Cambridge.

25th Annual Plant Science Seminar, August 2–5, College of Pharmacy, University of Washington, Seattle.

International Congress on Mental Health, August 11–21, London, England.

Comments and Communications

Creation of Mesons by High-Energy Particles

The construction of a number of electron synchrotrons in the United States raises the question as to whether it will be possible to observe the creation of mesons in these machines. It seems, therefore, to be of importance to have an estimate of the cross sections for the creation of mesons by nuclear particles, β- or γ-quanta.

The present state of meson theory is far from certain. Also, for low energies, in the neighborhood of the threshold, the Born approximation, generally used for the calculation of cross sections, is not too good an approximation, and for high energies it is still a more or less open question how, satisfactorily, to take into account radiation damping. Finally, for an exact calculation, one has to take into account the fact that the nucleons are moving in the Fermi gas in the nucleus, which is supposed to be at rest.

In view of all these points, it seems worth while to try to estimate the cross sections of meson production by simple dimensional considerations. The results obtained in this way are probably correct within factors of the order of magnitude of 10 and may give an indication of the phenomena to be expected.

This work is essentially an extension of the recent work of McMillan and Teller (*Phys. Rev.*, 1947, 72, 1). These authors determined the way in which the cross section for the creation of mesons depends on the energy of the bombarding particle by calculating the available volume in momentum space. Although their paper deals only with the case of a bombardment by nucleons, it is, of course, possible to use their method also for the case of a bombardment by β- or γ-quanta.

We shall first investigate the cross section for the creation of mesons in the neighborhood of the threshold, *i.e.* for the case where the energy of the bombarding particle is only slightly higher than the minimum energy required for the creation of a meson. In that case, the cross section can be written as the product of three factors. The first is a power of ε, where ε has the same meaning as in the paper of McMillan and Teller, whose notation we shall use throughout:

$$\varepsilon = \frac{E - E_t}{E_t}.$$

Here E is the energy of the bombarding particle; E_t, the threshold energy.

The second factor will be made up of factors e^2/hc and g^2/hc, g being the coupling constant of the meson field.[1] For every electromagnetic process involved in the reaction, we get a factor e^2/hc, and for every mesonic process, a factor g^2/hc.

The final factor will be $\pi\lambda_t^2$, where λ_t is the wave length of a bombarding particle with threshold energy. [Under the wave length of a particle with momentum p, we understand the quantity $\lambda = h/p$. For all practical purposes λ is equal to the Compton wave length of the meson, since $E_t \approx \mu c^2$ ($^t\lambda_t = h/p \cong hc/E \approx h/\mu c = \lambda_\mu$).]

In this way we get:

$$\sigma = K\pi\lambda_t^2 \, (e^2/hc)^a \, (g^2/hc)^b \, \varepsilon^c, \qquad (1)$$

where a, b, and c depend on the reaction considered and the kind of meson produced. Formula (1) is actually only the first term of a power series in ε, the higher-order terms of which we have neglected. In order to get the numerical constant K, one would have to calculate rigorously the matrix elements corresponding to the reaction considered. We shall assume that these matrix elements do not depend on ε and that K is of the order of magnitude of unity.

For high energies of the bombarding particle, we should expect the cross section to be given by:

$$\sigma = \pi\lambda^2 \, (e^2/hc)^a \, (g^2/hc)^b, \qquad (2)$$

where again we have assumed the matrix elements not to depend on the energy. The only energy dependence arises, then, from λ^2 or E^{-2}. We may draw attention here to the fact that McMillan and Teller have essentially the same formula as formula (2), without, however, the factors g^2/hc. It seems to us that this neglect of the influence of the coupling is the reason why they obtained a much larger cross section than Horning and Weinstein (*Phys. Rev.*, 1947, 72, 251).[2]

We have now to calculate the quantities a, b, c, in three cases, viz., bombardment by nucleons (A), by electrons (B), or by photons (C).

(A) In the first case, we can use the results of McMillan and Teller or Horning and Weinstein for the determination of c. We then get $c = 7/2$. In order to determine a and b, we have to remember that the reaction also includes, apart from the creation of the final meson, the emission and reabsorption of a (virtual) meson so that momentum can be conserved. Since no electromagnetic processes are involved, we have $a = 0$, $b = 3$, and we get for the final cross section in the neighborhood of the threshold:

$$\sigma_A = \pi\lambda_t^2 \, (g^2/hc)^3 \, \varepsilon^{7/2}, \qquad (3A)$$

which agrees with the formula of Horning and Weinstein, apart from a numerical factor of the order of magnitude of unity.

(B) If the bombarding particle is an electron, one can again use the same considerations as in case A to determine c. We have checked this result by actually calculating the available volume in momentum space ($\int d\mathbf{p}_n' \, d\mathbf{p}_n \, d\mathbf{p}_i'$), using Horning and Weinstein's method. For c we find, again, 7/2. The reaction can be described as

[1] The symbol, h, is Dirac's constant, *i.e.* Planck's constant, h, divided by 2π.

[2] I should like to express my thanks to Dr. Horning for writing me some details of the calculations leading to their final result. These have been of great help to me in checking some of the results of this note.

the emission of a (virtual) γ-quantum by the electron, the absorption of this quantum by a nucleon, and the subsequent emission of a meson. Hence, we have $a=2$, $b=1$, and

$$\sigma_B = \pi\lambda_t^2 \ (e^2/\hbar c)^2 \ (g^2/\hbar c) \ \varepsilon^{7/2}. \qquad (3B)$$

(C) In the final case, where we have the photomesic effect, we get for c the value 5/2. (The volume in momentum space reduces to $\int d\mathbf{p}_n' \ d\mathbf{p}_n$.) Since the reaction consists of the absorption of the photon and the emission of a meson, we have $a=b=1$, and

$$\sigma_C = \pi\lambda_t^2 \ (e^2/\hbar c) \ (g^2/\hbar c) \ \varepsilon^{5/2}. \qquad (3C)$$

We may remark here that the exponent of ε is different from that obtained by Nordheim and Nordheim or Yukawa (*Phys. Rev.*, 1938, **54**, 254; *Proc. phys. math. Soc. Japan*, 1938, **20**, 720; cf. also P. Urban. *Acta Phys. Austr.*, 1947, **1**, 167). This is due to the fact that these authors did not take into account the momentum of the nucleon in the Fermi gas.

In order to get an idea as to the absolute value of the cross sections for bombarding energies well above the threshold, we can calculate the cross sections for $\varepsilon=1$. Using $g^2/\hbar c = 1/6$, we get:

$\sigma_A = 2.10^{-4}$ barns, $\sigma_B = 4.10^{-7}$ barns, $\sigma_C = 6.10^{-5}$ barns.

We must remind the reader here that if nuclei of atomic weight A are bombarded, the cross sections have to be multiplied by A.

Comparing equations (1) and (2), it seems that one may expect an optimum energy for the creation of mesons to exist somewhere in the neighborhood of 300 Mev ($2\mu c^2$).

We may refer to McMillan and Teller's paper for a discussion of the various effects which they and we neglected. It should be remarked here that in cases B and C it is always possible to satisfy the law of conservation of momentum.

I should like to express my thanks to H. M. James and J. A. Wheeler for clarifying discussions on the subject of this note.

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The Use of Chemicals to Prevent Molding of Herbarium Specimens

Recently Fosberg (*Science*, September 12, 1947, pp. 250–251) discussed the use of formaldehyde to prevent molding of herbarium specimens. Johnson (*Science*, March 19, p. 294) found that this type of chemical treatment is without value in preparation of specimens of *Tsuga* and *Picea*. It is of interest to note that certain chemicals were used effectively by a botanist as early as 1854 to inhibit mold.

In a recent book (*A scientist with Perry in Japan*. Chapel Hill: Univ. of North Carolina Press, 1947), James Morrow recounts in his diary the difficulties experienced in preserving herbarium material collected mostly in Japan. On page 212 there is a statement that Morrow found some of the specimens beginning to mold, and also signs of insects working among them. He therefore painted the dried plants and flowers with a preparation of corrosive sublimate, strong spirits of wine, and camphor.

In a memorial presented to Congress after the return of the Perry expedition it is stated on page 264 that Morrow collected plants at different ports and that by painting with a chemical preparation he was so fortunate as to bring them to the U. S. without injury to a single plant.

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The Robert H. Goddard Rocket Project

The Robert H. Goddard Memorial exhibit sponsored by the Daniel and Florence Guggenheim Foundation, which was opened at the American Museum of Natural History on the afternoon of April 21 (*Science*, April 23, p. 420), is an admirable expression of appreciation of the late Dr. Goddard's scientific work. This exhibit is to be shown in other cities and later placed in some public institution for permanent display.

All who have been associated with the rocket project feel a deep sense of appreciation for the generous support which the Guggenheim Foundation has given to this scientific work during its later years and for the kind words regarding Dr. Goddard, expressed by Harry F. Guggenheim and Lt. Gen. James H. Doolittle at the exercises associated with the formal opening of the exhibit.

The conception of a rocket to be flown at terrific speed by jet propulsion and the earlier stages in this great adventure of a remarkable scientist, when much of the creative thinking was done, were not adequately covered in the addresses made at the Museum. Many institutions and individuals have contributed to this enterprise.

In his biographical sketch, Gen. Doolittle stated that Dr. Goddard was born in Worcester and graduated with a B.S. degree from the Worcester Polytechnic Institute in 1908. That is correct. No mention was made of the fact that Dr. Goddard transferred to Clark University for his graduate studies in physics and from that institution received his Master's degree in 1910 and his Ph.D. in 1911. He received the D.Sc. degree, *honoris causa*, from Clark University in May of 1945.

For a brief period (1912–13) Dr. Goddard was at Princeton, where he held a Research Fellowship. While there, he worked on the mathematical theory of rocket propulsion. He returned to Clark in 1914 as a member of the faculty and continued as a member of that staff until 1943, when he voluntarily resigned his professorship in physics to accept full-time employment in the laboratories of the U. S. Navy at Annapolis.

From the time Dr. Goddard joined the faculty of Clark University he gave most of his research time to the laboratory problems associated with jet propulsion and rocket flight. In this he was supported by the Uni-

versity and encouraged from time to time by special appropriations made by the Board of Trustees.

When I came to Clark in 1920, Dr. Goddard told me that he had proved, both mathematically and by actual tests, that the rocket would work in a vacuum. The rocket was to be propelled by the thrust produced by expelled gases created by the combustion of liquid fuels. Basically, it would be much like an ordinary Fourth of July sky rocket. Propulsion would be produced not by a push against air but recoil due to the sudden formation of gases. He knew that it did not need air or any other substance to push against. This led to the idea that such a rocket might go to the moon, and that brought a large amount of publicity. It is reported that a New York City policeman volunteered to be the first passenger to the moon.

Over and over again in those early years of the '20s, Dr. Goddard told me, as we worked together for additional appropriations, that his remaining problems were largely mechanical. He was endeavoring to overcome friction in the mechanism of his rocket and give strength to the structure where needed.

It was while Dr. Goddard was at work in the laboratories of Clark University that he proved that liquid fuels could be used in rocket propulsion. This antedated the use by the Germans of liquid fuels in a rocket by nearly 18 years. He also perfected a plan for cooling the rocket or avoiding excessive heat, which was of primary importance. He had developed the basic idea of the "bazooka" during World War I. That weapon, however, was not used until World War II.

Gen. Doolittle was right in pronouncing Dr. Goddard "one of the most remarkable men in the history of modern technology." He called him "founder of a whole new field of engineering," and said that "he fathered the basic research and development which led to the great expansion of rocket activity in World War II and which we may presume will give us the long-range control air weapons of the future." We should like to add that he was not only a skillful engineer; he was a man of vision and creative imagination.

In 1919 Dr. Goddard published a paper in the Smithsonian reports in which he gave his initial computations. In that same year he published another paper, "The Method of Reaching Extreme Altitudes." We urged him over and over again to publish more, but he was anxious to keep his work as secret as possible, for he knew others in distant lands were working on the same problem and that it had great significance in military affairs. A paper entitled "Liquid-Propelled Rocket Development" was published for Dr. Goddard in 1936.

During these early years the Smithsonian Institution, under the leadership of Charles G. Abbott, made several financial grants in support of the rocket project. This was a critical period and the financial help was most welcome. The late John C. Merriam, when director of the Carnegie Institution in Washington, took a very keen interest in this project and arranged for a substantial financial contribution from that institution to Clark University for the support of the experiment. With the combined aid of Clark University, the Smithsonian Institution, and the Carnegie Institution of Washington, Dr. Goddard carried on year after year, until he actually demonstrated that he could produce a rocket which could carry heavy recording instruments into the air.

As the work proceeded, Dr. Goddard's personal interest seemed to be largely in the scientific investigation of the upper layers of the atmosphere. He showed me plans worked out in great detail for carrying instruments that would record air temperatures, air pressures, humidity, electrical conditions, radioactivity, and a device which he thought would collect a sample of air at the maximum altitude reached by the rocket. He also planned to send up a camera, by which he might possibly, by continuous exposure of a film, bring back important photographic shots. His plans were to have each instrument returned by a parachute and so tagged that it would be returned to him by the finder.

In 1929 a somewhat famous test was made from a field on the outskirts of Worcester, when one of the experimental rockets, about 11′ long and under control so that it would not go too far, attracted the attention of residents of that region by the noise of its initial explosion. Someone saw an object falling from the sky and reported that an aviator must have fallen from a plane. This report reached the fire and police departments and they, together with newspaper men, were soon on the spot. Dr. Goddard begged them not to give publicity to this incident, but it was such a good news item that the reporters could not resist the temptation to publish.

This experience led to such a scare in the vicinity of Worcester that Dr. Goddard found it necessary to request the government authorities at Camp Devens, about 25 miles north of Worcester, to grant him permission to carry on his field tests with rockets from an abandoned farm near the artillery range of that camp. Permission was secured, and late in 1929 he and his assistants were busily engaged erecting a steel tower 100′ high, from which the trial flights of sample rockets were to be started.

About this time a New York paper published a short article about the rocket experiments, which caught the eye of Col. Charles Lindbergh. This was a most fortunate occurrence. The reporters who could not be restrained had performed a most helpful service to Dr. Goddard, Clark University, and scientific research. Col. Lindbergh came at once to the University campus and went immediately to Dr. Goddard's laboratory. This was on November 23, 1929. The Colonel was at that time particularly interested in any research that would provide accurate information about the upper layers of the atmosphere. He and Dr. Goddard became good friends, and he returned to New York most enthusiastic about the possibilities in the rocket experiments.

Charles Lindbergh was a very close friend of Daniel Guggenheim, and because of his recommendations and conferences with Dr. Goddard, Mr. Guggenheim made a very generous contribution to the University for the

support of the work in which Dr. Goddard was engaged. This first grant came to the University early in July of 1930.

The experiments had been in progress for nearly 20 years, but there was much left to be done, and the project needed more financial support than we had ever been able to command. The generous contributions that came from Mr. Guggenheim and from the Guggenheim Foundation continued until early in World War II, when the U. S. Navy invited Dr. Goddard, with his entire equipment, to move into its laboratory at Annapolis.

When a laboratory was established for Dr. Goddard at Roswell, New Mexico, all the equipment at Clark University that would be of value in promoting the experimental work and construction of more rockets was shipped there. It fell to my lot to visit the Roswell laboratory and report to the Trustees on this work which was being carried on by one of our staff. At that time Dr. Goddard was on leave of absence so that he could give his full services to the experimental work. He had erected a one-story laboratory near his home. There he had a rocket under construction about 18′ in length which resembled in many ways the chief object in the exhibit now at the American Museum of Natural History. Several assistants were at work making delicate parts; large sheets of light metal were at hand, mangled parts of rockets that had been high in air were being studied, and a new gyroscope was under construction. We visited the field, several miles out of town, where trial flights were started. There a tower similar to that built at Camp Devens was ready for use and electric power lines brought the necessary spark for actually starting the combustion of the liquid fuels.

One of Dr. Goddard's chief problems while at work in New Mexico was to keep the rocket moving in a straight line. He told me then that he planned to attach a gyroscope to the rocket, and later did so. Little by little the mechanical problems of constructing larger and larger rockets were solved. Various new metals were experimented with in order to reduce weight and to give greater strength. Each trial flight helped to disclose the places that needed to be reinforced. Various fuel combinations were used.

From time to time the University received formal reports of the progress being made and requests for an extension of Dr. Goddard's leave of absence. The problem of maintaining our graduate work in physics with the head of the department away for several years was a tough one. The University sacrificed much for the sake of this project.

Soon after receiving the first grant from Mr. Guggenheim, I organized, for the University, a committee of outstanding scientists who would direct the continuation of the experimental work on the rocket and jet propulsion. On that committee were John C. Merriam, director of the Carnegie Institution of Washington; Charles G. Abbott, secretary of the Smithsonian Institution; Charles A. Marvin, of the U. S. Weather Bureau; Robert A. Millikan, of the California Institute of Technology; Walter A. Adams, of Mt. Wilson Observatory; Col. Charles Lindbergh, Trustee of the Guggenheim Aeronautical Foundation; John A. Fleming, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington; and Henry Breckenridge, of the Guggenheim Foundation.

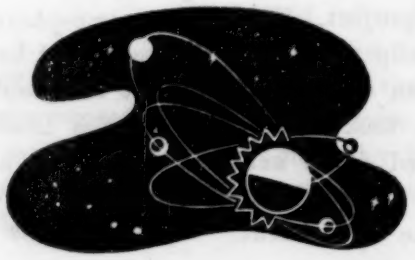
The meetings of this committee were held in the Board Rooms of the Carnegie Institution of Washington. Each time, Dr. Goddard came on from his New Mexico laboratory, presented a report of progress, and outlined the chief problems awaiting solution. On one occasion he brought a moving picture of a rocket in ascent. This group of men pooled their knowledge on the scientific and technical problems involved in the work and most frankly and generously helped Dr. Goddard in every way possible. The University was deeply appreciative of their services.

The imaginations of those now interested in jet propulsion are leading to predictions that are far beyond anything of which Dr. Goddard spoke. He did say that a rocket might some day be made that could reach the moon, but I never heard him prophesy interplanetary flight, or the transfer of mail and light cargoes in rockets at supersonic speed, or a rocket that might carry human passengers. All this may lie before us in the wonderful challenge which other men will accept.

All who know of this great adventure in science and technology are delighted with the announcement made by Harry F. Guggenheim that this field of research for peacetime service will receive additional support from the Guggenheim Foundation.

The work on the rocket and jet propulsion began in the same laboratory where A. A. Michelson first measured the speed of light and where Louis T. E. Thompson, director of research at the U. S. Naval Ordnance Testing Station at Inyokern, California, did much of his early scientific work on thermodynamics and ballistics. There Dr. Goddard served as an inspiring teacher and remarkably persistent research scientist. He was truly a great man who made many valuable contributions to science and technology.

WALLACE W. ATWOOD, *President emeritus*
Clark University



TECHNICAL PAPERS

An Unidentified, Filtrable Agent Isolated From the Feces of Children With Paralysis

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Several of last summer's small epidemics of poliomyelitis in upstate New York have been studied for evidence of mouse-adaptable viruses. An agent has been isolated from the acute-phase fecal specimens of two children from one outbreak which induces paralysis in suckling mice and hamsters. An additional unusual feature is that paralysis is associated with destructive lesions of the skeletal muscles, the central nervous system being unaffected. A brief preliminary statement is being made at this time, since others may wish to search for the agent this summer.

Patient T.T., a 9-year-old boy, was first examined by a physician on August 23, 1947. His symptoms were of 24 hours' duration and consisted of nausea, violent headache, and pains in both legs. His temperature was 104.0° F. No nuchal rigidity was found, but both legs were weak. Weakness was more marked in the trunk muscles and less so in the back. The boy was admitted to the Catskill Hospital, where cerebrospinal fluid was drawn and examined. The fluid was slightly cloudy and colorless, and contained 250 red blood cells and 64 leucocytes (kind not stated, other than that all types were present); the sugar was 50 mg/100 ml, and the globulin slightly increased. Weakness of the trunk muscles persisted. Seven months later the patient was still unable to sit up from a recumbent position, although his other muscles recovered.

The second patient, K.H., also a boy, was 3½ years old. His illness began on August 16, the initial symptoms being sore throat and lethargy. Two days later the adductor muscles of his left thigh were found to be very weak, but there was no nuchal rigidity. He was also hospitalized. His cerebrospinal fluid contained 10 erythrocytes, 2 polymorphonuclear and 2 mononuclear leucocytes/cu ml, 59 mg of sugar/100 ml, and normal amounts of protein. Six weeks later his adductors were still weak, and his left foot inverted when walking; 8 months later recovery was complete.

Isolation of the agent. Twenty per cent fecal suspensions, prepared by ether treatment and centrifugation, were inoculated intracerebrally into albino mice of the laboratory strain. Suckling mice, 3–7 days of age, became paralyzed, while mice 10–12 gm in weight did not. The isolations were repeated several times. Paralysis has not been induced in suckling mice more than 12 days of age. Numerous attempts to adapt the agent to weaned mice have failed. Similarly, only suckling hamsters are susceptible. After the initial isolation, paralysis in mice usually appears in 3–5 days and occasionally as late as 8 days. Paralysis also follows intraperitoneal or intramuscular injection. Thus far, paralysis has not been obtained in rhesus monkeys.

Mouse-brain suspension filtered through a Mandler candle failed to initiate growth in casein hydrolysate semisolid agar containing sodium thioglycollate at 35° C but induced paralysis in suckling mice and hamsters.

Neutralization tests have been made in suckling mice using one family for each dose of test material. Equal amounts of serum and infected mouse-brain suspension were injected intraperitoneally (0.05 ml) after standing 1 hr at room temperature. Neutralization was obtained with two pools of human serum and with human concentrated globulin without preservative. The acute-phase serum of patient K.H. had no neutralizing activity for either strain, while the convalescent-phase serum taken 24 days later neutralized both. The active-phase serum of the older patient had neutralizing activity which had increased approximately 10-fold in the specimen collected 23 days later and returned to its original value in a specimen collected in the 9th month.

The lesions in mice and hamsters consist of a severe and widespread degeneration of the skeletal muscles. The muscle cells lose their striations and become strongly acidophilic and fragmented. Intense proliferation of young muscle cells occurs and, with endothelial cell phagocytosis, gives the lesions a very cellular appearance. Particularly in late deaths the lesions are evident grossly as opaque, whitish streaks. Muscles of the limbs, the spinal groups, intercostal, masseter, and scalp muscles are among those affected; smooth muscle and the myocardium have been spared. Lesions have not been found in the central nervous system or large peripheral nerves.

The failure of the agent to propagate except in suckling mice or hamsters differentiates it from the Theiler viruses, MM virus, the virus of encephalomyocarditis, and the Lansing-like mouse-adapted poliomyelitis strains. Serologically, it failed to be neutralized by adult normal mouse serum or normal rabbit serum. Pooled human serum, human concentrated globulin, and, to some extent, normal monkey serum had a neutralizing effect. No neutralization was obtained with FA mouse encephalomyelitis mouse or rabbit serum, Lansing poliomyelitis mouse serum, MM virus rabbit serum, lymphocytic choriomeningitis monkey serum, or Aycock poliomyelitis monkey serum.

Repeated recovery of the agent from the fecal specimens and the immunologic response of the patients suggest that the agent is capable of infecting man. That it induces paralysis in man is unproven. The patients we have studied may possibly have been coincidentally infected with the new agent and classical poliomyelitis virus, although isolations were not successful in the rhesus

monkey. It his hoped that others will search for the agent and that the muscles of fatal cases of paralytic disease in the young will be thoroughly examined histologically.

Human Saliva as a Germination Inhibitor

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Dold and Weigman demonstrated in 1935–36 that human saliva contains a factor bacteriostatic and bacteriocidal to pathogenic bacteria.

Since various authors have shown that many antibiotics act as germination inhibitors on plant seeds (see *2*), we wished to find out if this is true also for human saliva.

Saliva was obtained from a number of persons of normal health not less than 1–3 hrs after eating and was used immediately after collection.

TABLE 1

INHIBITION CAUSED BY UNDILUTED HUMAN SALIVA

Age	Cases	Germination index
54	1	0 (0, 0)
"	1	0 (0, 0)
"	1	0 (0, 50)
"	1	0 (0, 62)
53	2	12 (7, 80)
"	2	14 (6, 50)
"	2	0 (0, 0)
"	2	6 (8, 60)
"	2	58 (15, 40)
"	2	0 (0, 0)
33	20	0 (0, 0)
6	23	0 (0, 0)
22	7	5 (12, 33)
22	24	16 (21, 14)
15	8	50 (50, 87)
"	8	56 (37, 50)
48	18	52 (40, 85)
16	25	71 (50,100)
36	11	60 (48, 44)
28	3	66 (30,100)
"	3	76 (30, 52)
25	12	68 (50, 52)
20	6	65 (52,100)
"	6	83 (24, 73)
"	6	80 (65, 50)
"	6	82 (50, 70)
26	10	66 (26, 50)
45	13	80 (71, 80)
21	4	80 (29, 77)
44	5	84 (50,100)
20	14	72 (33, 70)
15	15	72 (30, 50)
68	16	64 (33, 60)

The test method was the same as that described by Konis (*3*). We used 50 wheat seeds/Petri dish and 7–8 ml of saliva. The countings were made 48 hrs after the beginning of each experiment.

The numbers given in our tables are germination indices, *i.e.* % of germinated seeds related to the germination percentage of the water controls = 100. The first number in parentheses gives the length of the radicle related to the radicle length of the water controls = 100; the second, the corresponding data for the coleoptiles.

TABLE 2

INHIBITION AND DILUTION

Case	Concentrations (%)	Germination index
1	100	0 (0, 0)
	50	0 (0, 8)
	25	62 (21,100)
2	100	12 (6, 89)
	50	94 (63,100)
	25	98 (63,100)
3	100	64 (33,100)
	50	70 (50,100)
	25	92 (70,100)
4	100	82 (29,100)
	50	90 (55,100)
	25	94 (77,100)
5	100	84 (51,100)
	50	96 (64,100)
6	100	84 (28, 73)
	50	88 (66,100)
	25	96 (77,115)
7	100	5 (13, 33)
	50	90 (19, 66)
	25	88 (59, 72)
8	100	48 (50, 88)
	50	40 (33,100)
	25	66 (76,100)
9	50	82 (35, 75)
10	100	66 (46, 57)
	50	82 (50, 51)
	25	98 (74, 96)
11	100	90 (50, 57)
	50	60 (53, 81)
	25	100 (70, 80)
12	100	68 (54, 54)
	50	92 (83, 61)
	25	96 (85, 70)
13	100	80 (71, 80)
	50	96 (84,100)
14	100	72 (33, 76)
	50	100 (63, 76)
15	100	72 (30, 50)
16	100	64 (30, 60)
17	100	82 (30, 60)
	50	88 (58, 80)
	25	84 (80, 80)
18	100	46 (39, 85)
19	100	90 (60, 71)
	75	88 (75, 93)
20	100	0 (0, 33)
21	70	22 (16, 0)
22	20	76 (180,155)
23	75	0 (0, 0)

The conclusions drawn from the results given in Table 1 are:

(1) In all cases the saliva exerted a germination inhibiting influence.

(2) Wherever there was a germination of the saliva

treated grains, the growth of the radicles was strongly inhibited.

(3) The growth of the coleoptiles is less affected than that of the radicles. This stands out clearly in cases where there was definite growth of the coleoptiles but

TABLE 3

INHIBITION CAUSED BY BOILED SALIVA

Cases	Fresh saliva	Boiled saliva
2	0 (0, 0)	0 (0, 0)
2	58 (10,90)	66 (10,90)
2	84 (25,90)	88 (50,90)
6	10 (10,50)	20 (10,40)

none of the radicles. (These seeds are designated as not germinated.)

(4) The degree of inhibition varied individually.

(5) The inhibition caused by the saliva of the same individual taken at different times differs sometimes.

(6) The inhibition does not depend on sex or age, nor does it show any relation to the condition of the teeth (*4*).

When dilutions of the saliva are used, the inhibition decreases strongly (Table 2). The growth of the radicles, however, is inhibited even in the higher dilutions,

TABLE 4

VOLATILITY TEST

Cases	Germination index of fresh saliva	Volatility effect
2	0 (0,0)	84 (98,100)

whereas the coleoptiles are less affected. It is a strange fact that in some cases the inhibition is stronger in a 50% dilution than in the original saliva.

When the fact that human saliva acts as a germination inhibitor had been established, the nature of the inhibiting agent was investigated. Osmotic pressure and pH, which in some cases are partly or mainly responsible for the inhibition (*2*), could be excluded, as an os-

TABLE 5

INHIBITION AFTER DIALYSIS

Cases	Germination index of fresh saliva	Germination index of dialyzed saliva
2	6 (8, 60)	80 (50, 50)
1	0 (0, 60)	76 (88, 96)
6	64 (54,100)	82 (50,100)

motic pressure of 1 atm and a pH of 6.4–7.0 do not cause any inhibition of germination (*2*, *3*).

The inhibiting factor is heat resistant, as boiling does not affect the inhibition (Table 3). The inhibition factor is nonvolatile (Table 4). The volatility test was conducted in the usual way (*3*) by putting the saliva into a large Petri dish into which a small Petri dish containing the test seeds was placed.

The inhibiting factor is mostly removed by dialysis (Table 5). In these experiments the saliva was dialyzed for 70–75 hrs. All the chlorides and the rhodan present in the saliva were removed by the treatment, whereas the urea content was not changed.

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The Visibility of Moving Objects[1]

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The visibility of moving objects and the converse problem of the visibility of stationary objects while the observer is moving are of practical importance and have received little study. The visibility of moving objects imaged on the peripheral retina has been investigated by Low (*1*). The present author (*2*) has shown that, even when the eye is permitted to move in an effort to follow a moving object, visual acuity deteriorates rapidly with increasing angular velocity of the object. This paper is concerned with visibility at higher angular velocities than those previously considered by the author and with the practical problem of the effect on visibility of the aspect from which the object is viewed. For the present purposes visibility is understood to require the recognition of the general form of the object, not the mere detection of its presence.

Let us consider the case of a thin disc-shaped object which moves in a straight line in a plane passing through the observer's eyes. Assume further, that this straight line is parallel to a line joining the nodal points of the two eyes. The normal or line perpendicular to the disc is in this horizontal plane and is normal to the line of flight. The maximum surface is presented to the eye under these conditions at the point of nearest approach of the disc. Movement of the observer's head or adjustment of any auxiliary apparatus readily permits realization of these conditions. The disc is assumed to be of negligible thickness and will, in general, produce an elliptical retinal image because of obliquity of view. The visibility of the image, were it stationary, would be closely proportional to its area provided that the ratio of the major to minor axis is not greater than 9:1 (*2*). However, the object is not stationary, and the eye follows it by moving in the direction of the minor axis of the retinal image of the object. This movement reduces acuteness of vision, and, for present purposes, the lesser dimension of the retinal image will be considered as the dimension determining the visibility or lack thereof of the object. Take the nodal point of one eye as the origin

[1] This investigation was supported in part by a grant from the American Optical Company.

of a two-dimensional rectangular coordinate system. In the lesser, or x, dimension the disc subtends at the eye an angle $\theta^0 = \tan^{-1} \frac{sy}{x^2+y^2-\frac{s^2}{4}}$, where s is the diameter of the disc in feet. Since this angle is small and $x^2+y^2 >> s$, $\theta^0 = 57.3\frac{sy}{x^2+y^2}$. This is the angle available for vision.

The angle necessary for vision, however, is dependent upon the angular velocity of the object. The data presented in Fig. 1 show some results obtained by the author

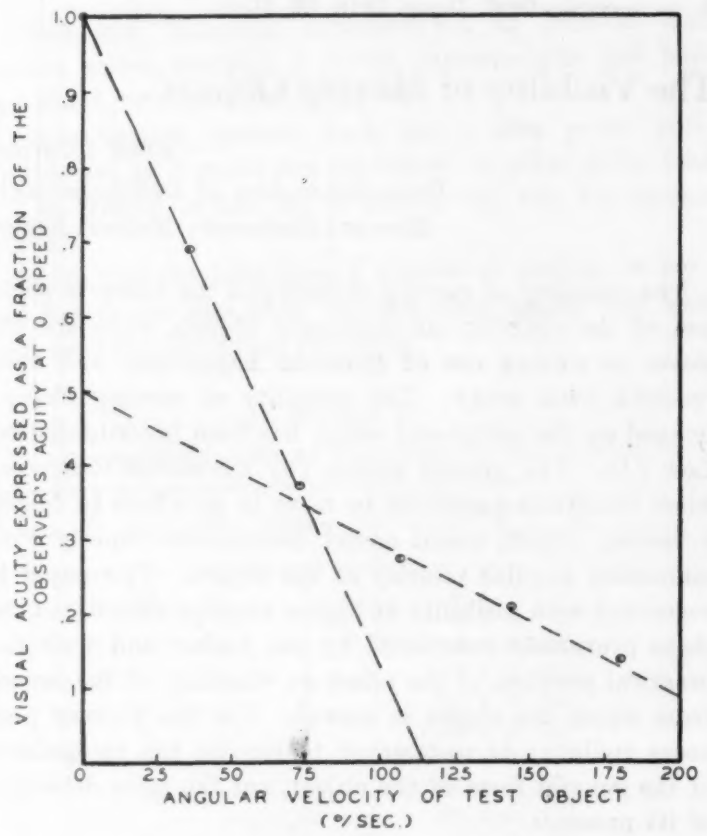

FIG. 1

during a general experimental investigation of visual acuity for a moving object. These data are more extensive and involve higher angular velocities than have been previously employed (*3*). The data are for monocular vision and constant angular velocity around the nodal point of an eye in the horizontal plane with head erect. The test objects were Landolt rings.

At relatively low angular velocities the expression V.A. $= 1 - .0088\alpha$ is a reasonable empirical fit to the data, while at high angular velocities the expression V.A. $= .5 - .0021\alpha$ is more appropriate. In general, V.A. $= a - b\alpha$ for a limited range of values of α. A stationary black disc on a bright background may be seen when its diameter subtends 25–30″ of arc at the eye (*4*); however, its shape cannot be discerned. On the other hand, some internal detail of an object may be perceived if the whole object subtends 5′ of arc (*4*). We may assume an intermediate value of 2′ of arc, or .033°, as the angle necessary to recognize a disc as a disc when it is stationary. The angle necessary for vision of the disc as a disc when acuity is reduced by moving the object is then $\beta = \frac{.033°}{a - b\alpha}$, where α is the angular velocity in degrees/sec. This velocity is given by $\alpha = 57.3\frac{vy}{x^2+y^2}$, where v is the linear velocity in feet/sec, or, substituting $\frac{1}{z} = \frac{y}{x^2+y^2}$, $\alpha = 57.3\frac{v}{z}$.

For visibility, $\theta = \beta$, or $57.3\frac{s}{z} = \frac{.033}{a - 57.3\,b\frac{v}{z}}$. From this $v = \frac{1}{57.3\,b}\left(az - \frac{.033\,z^2}{57.3\,s}\right)$ and, setting $\frac{dv}{dz} = 0$, the maximum velocity at which the disc can be perceived as such is given by $v_{max} = \frac{7.5\,a^2\,s}{b}$. This equation permits the calculation of the maximum velocity in m.p.h. at which a disc of a given number of feet in diameter can be recognized as a disc at any point along its course. If contrast, aspect of view, and other conditions of vision are not optimal, the maximal velocity allowing recognition will be still lower and the disc cannot be seen anywhere along its course.

It may be calculated from the last equation that a tea-cup 4″ in diameter traveling at velocities greater than 205 m.p.h., that a saucer (6″) traveling more than 30[illegible] m.p.h., and that a large dinner plate (10″) flying in excess of 510 m.p.h. could not be seen. In terms of the present simplified analysis it may be further observed that the mere use of optical magnification, otherwise unaided, could not be beneficial and, because of vibration, decrease of field and other factors, would be detrimental. Similar considerations apply to mere magnification by electronic means. A magnification of size without loss of contrast and without increase in angular velocity would be helpful.

Let us define the degree of visibility as the ratio of the angle available for recognition, θ, to the angle necessary for recognition, β. Then visibility $= \frac{\theta}{\beta}$, and for flight at constant value of y, setting $\frac{\partial\frac{\theta}{\beta}}{\partial x} = 0$, we obtain $x = \pm\sqrt{\frac{(2)(57.3)b}{a}vy - y^2}$; therefore, as v increases, x increases, and the point of maximum visibility recedes from the observer.

It now becomes apparent that, as the linear velocity of an object increases, the point of maximum visibility recedes farther and farther from the point of nearest approach of the object to the observer until the object is no longer visible, simply because it is too far away. This, then, explains the large number of cases of inability to recognize moving objects when they are moving slowly enough so that they can actually be seen. Similar reasoning will apply in practical problems where one wishes to determine the conditions necessary for maximum visibility, e.g. the optimal altitude and velocity of flight for the identification of life rafts, downed planes, etc., and in the design of instruments intended to be employed for the identification of aircraft, missiles, etc.

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IN THE LABORATORY

Methods of Automatic Watering of Plants

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The usual method of surface watering of bench crops and potted plants is a time-consuming operation, and, because of lack of sufficient labor, plants in many research investigations are not adequately watered. In recent years several methods (*1–5*) of automatic watering of bench crops and potted plants have been developed for research and commercial use in the field of floriculture. The constant water level system is the simplest and has worked well in the production of all types of florists' crops.

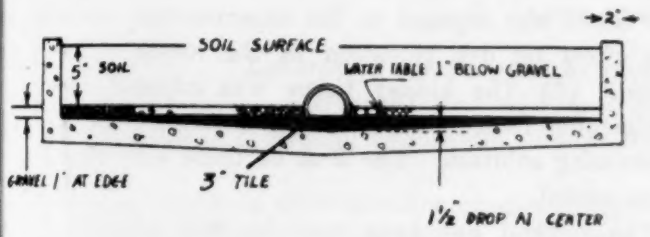

FIG. 1. Arrangement of bench for automatic watering of bench crops.

Bench crops. Tile is placed lengthwise in the middle of a water-tight bench (Fig. 1). Pea gravel to a depth of 1″ at the side of the bench is leveled, and the bench is filled with soil. A constant water table is maintained in the bottom of the bench about ¾–1″ below the soil by means of a float valve in a tank on the side of the bench. The water moves through the soil by capillarity.

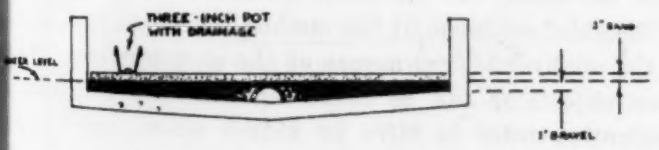

FIG. 2. Bench with pot on sand for automatic watering by the constant water level method.

Potted plants. The plants are placed on a layer of sand in a water-tight bench with a constant water table 1″ below the pot (Fig. 2). The water table should not contact the bottom of the pot. Water moves from the water table in the bottom of the bench through the sand, through the walls of the pot, and through the soil in the pot. As water is removed from the soil by plants and by evaporation, more water moves into the soil by capillarity. If the plants do not obtain sufficient water automatically, more sand is added and the pots are plunged; large pots generally have to be partly plunged. Several other automatic and semiautomatic methods of watering plants are also described in the references presented.

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Use of Thin Kidney Slices and Isolated Renal Tubules for Direct Study of Cellular Transport Kinetics

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The techniques described here were developed with the intention of examining active cellular transport by a simple, direct method which would obviate the more complicated tissue culture procedures. Thin slices of kidney or kidney fragments were obtained as for the Warburg manometric techniques, but here the kinetics of phenol red concentration in the lumina of renal tubules was observed *in vitro* rather than the nature of gas exchange by the excised tissue. It was hoped that this method would be useful in rapid screening to test the possible effects of chemical and physical agents on renal tubular secretion and also permit an examination of the nature of the secretory process itself through a study of metabolic competition and an analysis of specific stimulants and depressants of dye transport.

Active cellular transport is characterized as the performance of work empowered by the expenditure of some fraction of the energy in cellular metabolic reactions. It seems to be a general property of living organisms to produce striking differences in concentrations across their boundaries by the constant expenditure of energy to maintain steady states sometimes far removed from chemical equilibrium. Hill (*3*) states: "Throughout we are involved, not with genuine equilibria, but with conditions maintained constant by delicate governors and by a continual expenditure of energy. How that energy is supplied, how it is utilized to maintain the structure and the organization, is, I think, the major problem of biophysics." Such examples of steady state in the renal tubule are found in the selective elimination of metabolic end-products as urea and uric acid in the lower vertebrates, and of diodrast, *p*-amino hippuric acid, and phenol red by all the vertebrate kidneys. The selective reab-

sorption of amino acids, and particularly of sugars, by the cells of the renal tubules is well known. In the latter instance glucose concentrations of 250–300 mg% in the glomerular filtrate are reduced to zero in the collecting ducts as the urine travels the length of the renal tubule. Cells in the distal convoluted tubule finally achieve a steady state in which the concentration of sugar on one side in the tubular urine is zero, while the peritubular fluid on the other side of the cell may contain glucose in concentrations up to 300 mg%.

The selective transport of phenol red from peritubular circulation to tubular urine has been described by perfusion experiments and clearance techniques in representatives of all the vertebrate classes. Its tubular maximum has been carefully measured, and in every animal studied the essential characteristics of its secretory process are similar. As such, it constitutes a good example for study as a representative of those substances selectively eliminated by active cellular transport (*2*).

The procedures employed here are extremely simple. Thin slices of kidney tissue were prepared by free section with a razor blade or by guided section with the tissue lightly compressed between frosted glass plates (*6*). The slices were then placed immediately in a solution of precisely known chemical constitution containing between 1 and 2.5 mg% phenol red and actively oxygenated. Customarily, at the end of 5, 15, and 30 min, the slices were removed temporarily from the solution and examined without a cover slip under low power of the microscope to detect whether phenol red had or had not been concentrated in the tubular lumen and, if so, to what degree.

A satisfactory preparation was obtained by sectioning the kidneys of small frogs to obtain 4 or 5 longitudinal slices from each kidney. The following solution has been found to produce optimal phenol red concentrations in controls: 0.580% NaCl (100.0 mM), 0.019% KCl (2.5 mM), 0.022% $CaCl_2$ (1.5 mM), 0.020% $MgCl_2$ (1.0 mM), 0.126% $NaHCO_3$ (15.0 mM), 0.007% NaH_2PO_4 (0.5 mM), 0.054% $C_6H_{12}O_6$ (3.0 mM), phenol red: 1–2.5 mg %. Each of the foregoing components has been individually tested for optimal concentrations. The relatively high bicarbonate content is particularly important in inducing active phenol red transport. The solution without glucose is stable indefinitely. Customarily, glucose is added to the previously prepared solution on the day of the experiment. Kidney slices from frogs and other cold-blooded animals show definite phenol red concentration in some tubular lumina within 5 min after immersion in this medium at room temperature with oxygen actively bubbling through. Progressive increases both in number of tubules concentrating the dye and in intensity of the red color within the lumina will be noted for hours. The cells of the renal tubule remain colorless or take on a light yellow cast, while the color in the lumen ranges from light pink to very deep red, depending on the level of the tubule being examined, the distance of the tubule from the exposed surface, etc.

Microcolorimetric readings have been made with known concentrations of phenol red in glass capillary tubes drawn to the approximate diameter of renal tubules. When placed alongside the slice preparation, these comparis standards indicated that in the distal portions of t tubule concentrations as high as 50 times or 250 mg were obtained.

In a second procedure it was found that renal tubul could be isolated for individual study. Fish kidne seem to have little cementing substance and it was notic that upon transferring fragments of fish (sculpin, flou der, and trout) kidneys to the sustaining medium the i dividual tubules separated from one another as a res of the mechanical agitation of oxygen actively bubbli through the solution. This proved to be a very satisf tory preparation characterized by a high rate of d transfer, presumably due to the relatively complete e posure of the individual tubules to the solution.

Three variations in procedure have been employe (1) The excised tissue was placed directly in the oxyge ated phenol red solution, which already contained t experimental agent, and the effect of the variable on t kinetics of dye transport in inhibiting or stimulati phenol red concentration in the renal tubule lumen w noted by comparison with a control. (2) Phenol red w allowed to be concentrated in the tubule lumen befo the tissue was exposed to the experimental variable a the effect on dye retention in the lumen subsequent noted. (3) The kidney tissue was exposed to the e perimental factor before being immersed in the dy containing solution. The first of these was found to most useful.

The method has been used in this laboratory in variety of problems. Some of these are: the effects ionic unbalance, disturbances in osmotic equilibri temperature effects, narcosis and anoxia, competition a substitution in the dye transport system, iodoacetat pyruvate, succinate, and lactate effects for energy sour analyses and for screening the actions of specific pharm cological agents.

Kidneys from representatives of all classes of the v tebrates have been studied with these techniques. T method has not yet been successfully adapted to sli from the kidneys of mammals (rabbits, rats, and mice).

The chief criticism of the method described here rela to the unphysiological nature of the preparations. Th same objections can be raised against measurements respiration rates *in vitro* by kidney slices, minces, a homogenates. Renal clearance techniques have been d veloped which measure with great accuracy the vari aspects of kidney function in normal unanesthetiz animals and man. However, in the intact animal it obviously impossible to test the effects of toxic enzy inhibitors such as iodoacetate, cyanide, and fluoride, a it is frequently very difficult to separate the extrare side effects which might cause variations in renal blo flow, blood pressure, chemical composition of the blo or other factors difficult to control with the kidney integral part of the intact organism. This meth obviates the necessity of tissue culture techniques so fr fully utilized by Chambers and his group in studies m on cystic explants of the mesonephros of the chick a other embryos (*1*), and it more closely approxima

high rate of dye transport characteristic of the intact kidney than is obtained with studies made on excised whole organs (*4*, *5*). It can be recommended as a simple and useful procedure which might be profitably employed in a wide variety of studies on the physiological and biochemical nature of cellular function in renal tubules.

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Magnetic-Flea Agitating Device for Microtitration

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It is often desirable in microtitration studies to agitate the mixture while adding an ingredient. This can be accomplished in admirable fashion by the "magnetic flea"—a small iron powder magnetic core, surrounded by

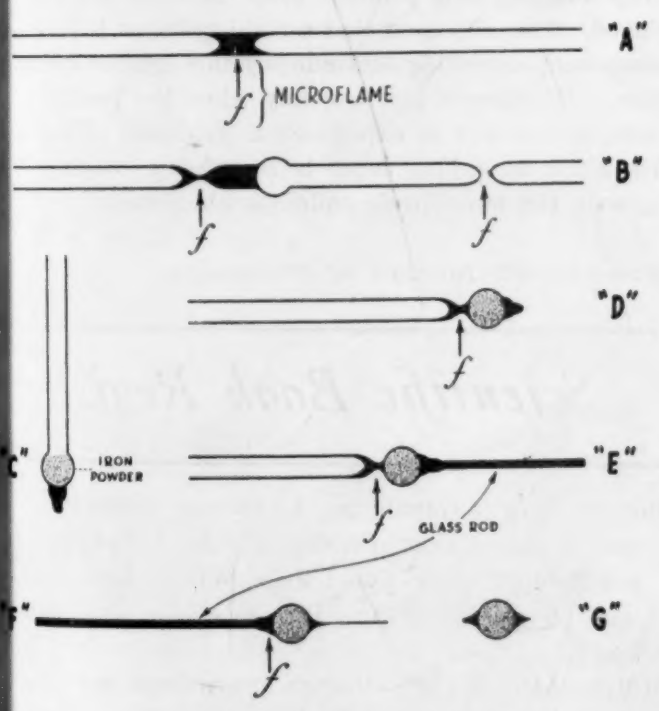

FIG. 1

and caused to move up and down in the titrating vessel by an interrupted magnetic field.

The "magnetic flea" is made by taking a length of thick-walled Pyrex glass capillary tubing, which may vary in thickness from 0.75 to 1.5 mm o.d., and collapsing a portion of it near one end over a microflame (Fig. 1A). A small bubble is blown just above the collapsed portion (B). The open end of the capillary is now pushed into a bottle of iron powder (not filings) and inverted to allow the powder to fall through the tube and completely fill the bubble (C). The bubble is then sealed off from the rest of the capillary (D). By sealing a small glass Pyrex rod to alternate ends of the bubble, the excess glass may be heated and removed from the opposite ends of the glass bubble (E, F).

A very easy alternate method for making the "magnetic flea" is to proceed through the steps taken in making a Cartesian diver in a diver jig (*1*).

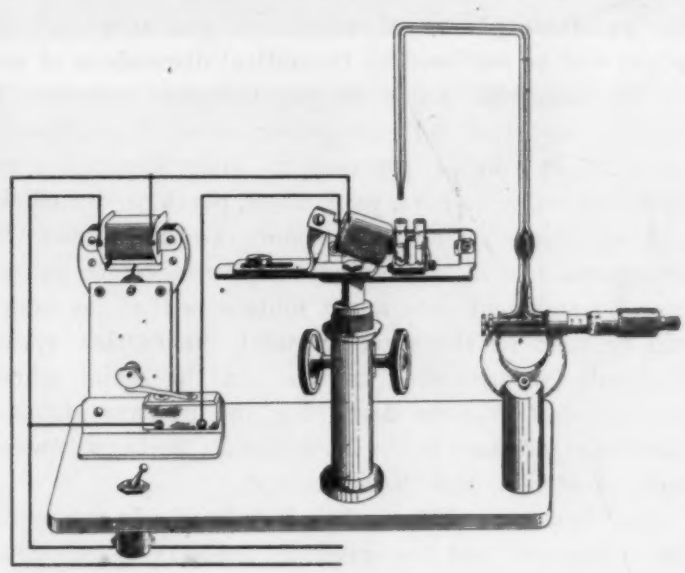

FIG. 2

Before the neck of the Cartesian diver is cut, it is essentially as shown in Fig. 1C. The capillary is cut approximately 50 mm from the bubble, filled with iron powder, and sealed off near the bubble. The rest of the procedure is as outlined. The finished "flea" should look like Fig. 1G.

The agitating device consists of a synchronous motor,[1] the shaft of which is fitted with an eccentric cam which operates a microswitch[2] which in turn opens and closes an electric circuit, passing through an electromagnet (Fig. 2). This provides an interrupted magnetic field which causes the "magnetic flea" to rise and fall in the titration vessel. The electromagnet may be fashioned from a coil of a 110-v, 60-cycle relay. The electrical circuit is outlined in Fig. 2, in which a convenient assembly incorporating a Scholander microburette (*2*) is shown. The entire assembly placed in front of the opal glass of an X-ray viewer gives maximum comfort in matching colors during titration.

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[1] Available in several r.p.m. from Hansen Manufacturing Company, Inc., Princeton, Indiana.

[2] Mu Switch, Canton, Massachusetts.

Book Reviews

Encyclopedia of vocational guidance. (Vols. 1 & 2.) Oscar J. Kaplan. (Ed.) New York: Philosophical Library, 1948. Pp. xxi + 1422. $18.50.

The editor of this most significant two-volume work modestly states in the preface that "this book is encyclopedia in a relative sense; it does not pretend to cover in great detail all phases of the guidance field." Though the statement is literally correct, the compilation is a monumental contribution to applied science. The material presented is concise, clear, pragmatic, and sufficiently comprehensive to serve well those who are concerned with the practical phases of vocational guidance and who might well be confused by theoretical discussions of some of the unsettled areas of psychological science. Dr. Kaplan has assembled an imposing array of contributors, some 287 in number, representing many disciplines such as education, economics, psychology, psychiatry, medicine, and statistical science. The more useful aptitude test procedures are well presented, and the reference material includes sufficient data anent sources so that the articles can be used as the starting point for further studies. Particularly interesting to those in the social sciences are the contributions describing the postwar status of vocational guidance in the Netherlands, Portugal, Switzerland, Australia, and New Zealand.

The significant shifts in age distribution in our population structure and the growing problem of vocational placement of the aging and those with various handicaps from traumatic (war) injuries or chronic progressive diseases of later maturity make vocational guidance of immediate and urgent concern to millions of individuals. For professional counselors and personnel administrators, medical clinicians, ministers, nurses, educators, insurance administrators, the military forces, public health officials, veterans administration personnel, and even legislators, the work is very nearly a *must*. The multiple-discipline approach is a significant step forward in the application of science to social planning.

The volumes are attractively bound but are unnecessarily bulky because of the poor quality of the paper; future printings deserve a much better grade of material. The typography is good. The alphabetical encyclopedia arrangement of the contributions avoids the necessity of an index.

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Modern colloids: an introduction to the physical chemistry of large molecules and small particles. Robert B. Dean. New York-Toronto-London: D. Van Nostrand, 1948. Pp. xi + 303. (Illustrated.) $3.75.

This latest addition to the literature on colloid chemistry in textbook form starts with a definition of what colloid science is, a discussion of types of colloids, and a list of sources for published information. The following chapters cover methods for determining size and shape of colloidal particles, liquid surfaces and their characteristics, adsorption phenomena and their application in science and industry, and high polymers, their synthesis and properties. Special chapters are devoted to plastics, resins and rubber, carbohydrates and proteins, emulsions and foams, hydrous oxides and silicates, and also to colloidal ions and their electrokinetics and to lyophobic colloids or suspensoids.

The author deserves credit for writing a book to stimulate the interest in colloid chemistry in such diversified fields as chemistry, biology, medicine, and agriculture. The reviewer, a colloid chemist himself, feels, however, that the book covers far too much for an introduction to colloid chemistry and that its organization is more apt to confuse the reader than to enlighten him. In addition, it will give the reader who is not familiar with what modern colloid chemistry already stands for an entirely wrong impression. To offer some proof for this opinion, the following examples might suffice:

The physics and chemistry of surfaces is not just an intimate part of colloid science, but colloid science itself. The statement that nearly all of the properties of lyophobic colloids are due to the presence of impurities is contrary to well-established facts.

A more elaborate discussion of ultramicroscopes, their construction, and application would be far more appropriate than writing a eulogy of the electron microscope which also has its limitations, particularly when studying lyophilic colloids. Ultramicroscopy by incident light and its applications in research pertaining to lyogels is not mentioned. That solutions of proteins and other high polymers show no Faraday-Tyndall effect is contrary to fact. In the chapter on liquid surfaces, the drop weight, drop number, and pendant drop methods are not mentioned. The statement that a rigid gel must have its solid component extending continuously through the system and that a thixotropic gel sets only when the particles associate is contrary to experimental evidence. Finally, the discussion of rubber latex is incomplete because it disregards the most basic colloidal phenomena.

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Scientific Book Register

BORING, EDWIN GARRIGUES, LANGFELD, HERBERT SIDNEY, and WELD, HARRY PORTER. (Eds.) ***Foundations of psychology.*** New York: John Wiley; London: Chapman & Hall, 1948. Pp. xv + 632. (Illustrated.) $4.00.

MCLACHLAN, N. W. ***Modern operational calculus with applications in technical mathematics.*** Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1948. Pp. xiv + 218. (Illustrated.) $5.00.

SUITS, C. G., HARRISON, GEORGE R., and JORDAN, LOUIS. (Eds.) ***Applied physics: electronics, optics, metallurgy.*** Boston: Atlantic-Little, Brown, 1948. Pp. xiii + 456. (Illustrated.) $6.00.